Description

Method for Operating a Transmitting Device and Working
Transmitting Device

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The invention refers to a method for operating a
transmitting device with a plurality of longwave antennas
of an access system of a vehicle, in particular of a motor
vehicle. It further refers to a transmitting device working
10 accordingly.

An access system of this type, which often is referred to
as passive access system (passive entry system), usually
forms part of a higher-ranking keyless remote control
15 system, which in addition to the automatic release of a
vehicle door also controls its motor starting system and/or
an anti-theft device. Such system comprises a transmitting
device or transponder, integrated for instance into the
vehicle key and carried along by a person authorized for
20 the vehicle, and a vehicle based transceiver.

For ascertaining an access authorization to the vehicle
between the portable transponder and the vehicle based
transceiver redundant codes or access data are exchanged
25 based on high-frequency (HF) and/or low-frequency (LF) –
and thus short-wave or long-wave carrier signals. Local
detection of the transponder is performed via divers
longwave antennas arranged in or distributed all-over the
vehicle.
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According to a passive remote control system known from DE
101 08 578 A1 the longwave antennas can be sequentially
activated by a vehicle based control system. In case of the

known system the transponder answers to such a longwave-based interrogating signal with a redundant-coded HF-signal for identifying the access authorization. Where applicable, a vehicle-based control system unlocks the vehicle door, so

5 that it can be opened by manually operating the door handle.

By sequentially activating the longwave antennas, in fact, the energy to be delivered by the vehicle battery for

10 triggering the longwave antennas can be kept low. However, according to a keyless access system known from DE 198 35 155 A1 the transmitter antennas are usually individually triggered by means of separate drivers, resulting in a considerable circuit expenditure in particular with high

15 requirements to the driver output stage.

It is, therefore, the object of the invention to indicate a method of the type mentioned above, which allows for a preferably low-loss triggering of a plurality of longwave

20 transmitter antennas of a transmitting device of a vehicle access system. Furthermore, a transmitting device, in particular for the door control of a motor vehicle shall be indicated which is particularly suitable for implementing the method.

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The invention is achieved by the features of the independent claims. Advantageous further embodiments of the method are object of the sub-claims referring back hereunto.

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The advantages achieved with the invention are in particular that by direct triggering of all longwave-transmitter antennas jointly and their individual

activation by means of a multiplexer device a reliable transmitting operation is achieved with a circuit or component arrangement which simultaneously requires particularly low space and thus is effective. By the direct

5 triggering of the longwave transmitter antennas on the one hand a particularly reliable local detection and on the other hand a particularly reliable energy transmission in a transponder, in particular an intelligent vehicle key, is achieved.

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By using a power amplifier with limited rise time and optimized saturation behavior, furthermore particularly low-loss triggering with simultaneous restriction of the electromagnetic radiation to a reliable value without

15 additional filter measures at the amplifier outlet is achieved.

Further, by the direct triggering of the longwave transmitter antennas formed by transmitter coils in series

20 resonance, by means of a trapezoidal voltage the circuit expenditure and thus the cost expenditure is particularly low, especially as several transmitting devices can be triggered from a central control device and the transmitter antennas can be connected directly to the amplifier outlet.

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Moreover, by controlling the sinusoidal transmitter current while restricting its peak value by means of a fast power off and by a synchronization by pulse-width modulation at the control input of the amplifier its output power can be

30 steadily adjusted to a particularly high activity value. This allows for operating the amplifier output stage in saturated manner, so that in its driver or driver stage there is only a low power loss.

An example of embodiment of the invention is explained in detail in the following taken in conjunction with the drawing.

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FIG. 1 shows schematically in a block diagram the circuit of a transmitting device with an individual amplifier and a plurality of transmitter antennas,

10 FIG. 2 shows a comparatively detailed circuit of the block diagram according to FIG. 1,

FIG. 3 shows a signal diagram for illustrating the functionality of a current regulation of the transmitting
15 device, and

FIG. 4 shows a circuit principle of the amplifier of the transmitting device.

20 In all figures like elements refer to identical reference numerals.

FIG 1 shows schematically in a block diagram a transmitting device 1, which for instance is part of a door control of a
25 motor vehicle access system. The transmitting device 1 comprises an amplifier device in form of a central amplifier 2, whose operating voltage U_B is delivered by the vehicle battery (not shown). At the outlets LF_{out} of the amplifier 2 a plurality of longwave transmitter antennas
30 $LF_{1...n}$, hereinafter referred to as antennas, are directly and jointly connected. The antennas $LF_{1...n}$ are individually activated by a multiplexer device or a multiplexer 4 and are connected at a certain order and time sequence and thus

are successively activated. For this purpose the
multiplexer device 4 connected downstream of the antennas
$LF_{1...n}$ is connected against ground GND.

5   In the ground branch 6 of the multiplexer 4 a shunt 8 for
measuring current is connected, which forms part of a
current regulation 10. The current regulation 10 comprises
a current detector 12 in the form of an over-current
comparator, to the one input thereof - here the (+) input -
10 a referential signal I_{Ref} and to the other input thereof -
here the (-) input - a transmitter current I_{LF} guided via
the antennas $LF_{1...n}$ and the multiplexer 4 is supplied.

On the output side the current detector 12 is connected to
15 an input E_1 of a control logistics 14, at the second input
E_2 thereof a low-frequent clock signal LF_{clk} with a frequency
of advantageously 125kHz is guided. On the output side the
control logistics 14 is connected to a control input P_{in} of
the amplifier 2.
20
When operating the transmitting device 1 the amplifier 2
triggered on the input side with the low-frequent trigger
signal LF_{clk} produces on the output side a trapezoidal
voltage, which is used via the amplifier outlet LF_{out}
25 directly for jointly triggering the antennas $LF_{1...n}$. Here,
the antennas $LF_{1...n}$ are successively connected to the
amplifier 2 by means of the multiplexer 4 in a time
sequence capable of being predetermined. This allows for a
particularly low-loss triggering.
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The transmitter current I_{LF} guided via the respectively
activated antenna LF_n is detected by means of the shunt 8 at
the multiplexer 4 on the ground side and is supplied to the

(-)-input of the current detector 12 hereinafter referred to as over-current comparator. This over-current comparator compares the transmitter current I_{LF} with the referential value I_{Ref}. When the referential value I_{Ref} has been exceeded

5 current restriction of the transmitter current I_{LF} is effected by means of the current regulation 10 to the referential value I_{Ref} capable of being predetermined, which represents the desired value of the current regulation 10. For this purpose the over-current comparator 12 produces on

10 the output side a control or trigger signal S_T, which is supplied via the control logistics 14 to the input P_{in} of the amplifier 2 for controlling the output power of its output stage. With a corresponding Q of the transmitting device 1 effective as a transmitting circle this causes the

15 actual value of the transmitter current I_{LF} to be adapted with good approximation to the desired value I_{Ref}.

As can be seen from the comparatively detailed circuit according to FIG. 2, each longwave-transmitter antenna LF_n

20 is embodied as a transmitter coil L_n, which is coordinated to series resonance by means of a condenser C_n which is series connected to this transmitter coil L_n. The multiplexer 4, downstream connected to the antennas LF_n, which by means of square wave voltage are directly

25 triggered by the amplifier 2, is advantageously embodied in MOSFET-technology.

For this purpose the multiplexer 4 comprises in each antenna branch AZ_1 to AZ_n a power transistor (MOSFET), which

30 is triggered on the gate side by means of a corresponding control signal M_c for activating the respective antenna LF_n. As a result, merely the power transistor, respectively triggered, of the multiplexer 4 guides the (entire)

transmitter current I_{LF} due to the triggering of the antenna LF_n arranged in the corresponding antenna branch AZ_n by means of square wave voltage produced by the amplifier 2. The embodiment of the multiplexer 4 in SMART-MOSFET-

5 technology advantageously produces a resistance of the arrangement against short-circuits of the antenna lines, with conventional MOSFETs particularly fast triggerings, e.g. for fast phase modulation, can be achieved.

10 Basically, also divers antennas can be operated at the same time, however, in this case only the cumulative current would be controlled.

According to FIG. 2 the control logistics 14 is composed of
15 a logical AND-element or -gate 16 and of a sequential circuit hereinafter referred to as PWM-latch. Advantageously, this is embodied as a flank controlled D-flipflop (latch-flipflop), which according to the signal diagram in FIG. 3 triggers onto the positive flank of the
20 clock signal LF_{clk}. This PWM-latch thus serves for synchronizing the control or trigger pulse S_T with the clock LF_{clk} and for pulse-width modulation (PWM) of the input signal P_{in} of the amplifier 2. This results in that the sinusoidal transmitter current I_{LF} - and the transmitting
25 power - are regulated by peak value restriction of the transmitter current I_{LF} by means of a fast power off and a pulse-width modulation synchronization.

To this end the control signal or trigger pulse S_T,
30 delivered by the over-current comparator 12 on the output side, which signal S_T is formed by comparing the transmitter current I_{LF}, measured in the ground branch 6 of the multiplexer 4, with the desired or referential value I_{Ref},

is used for triggering the PWM-latches 18.

As is illustrated in FIG. 3, here, the over-current
comparator 12 does not trigger and the PWM-latch 18
5 continues to be set over the period referred to as t_1 (Q_{Latch}
= high), as long as the referential value R_{Ref}
predetermining the maximum value of the transmitter current
I_{LF} is not exceeded. With that the input clock LF_{clk} (50%
duty cycle) is applied at the input P_{in} of the amplifier 2
10 and its output stage controls the complete output power.

If, however, the transmitter current I_{LF} exceeded the
maximum or peak value predetermined by the referential
value I_{Ref}, the over-current comparator 12 switches and the
15 thus produced control signal S_T resets - in the illustrated
period t_2 - the PWM-latch 18 (Q_{latch} = low). Based on the
linkage with the clock signal LF_{clk} serving as an input
clock by means of the AND-gate 16, the pulse width at the
input P_{in} of the amplifier 2 is modulated such that the
20 maximum or peak value of the transmitter current I_{LF}
corresponds at least approximately to the referential or
desired value I_{Ref}. By this short-circuit protection the
transmitting device 1 cannot only be used in a door control
system, but rather also in a central control system, which
25 in addition to the access system comprises also a motor
starting control and/or an anti-theft device of the
vehicle.

The amplifier 2 can be deactivated via an ENABLE-input E_{ebl},
30 so that current consumption in the idle state of the
transmitting device 1 is negligible low.

In accordance with the illustration in FIG. 4 the amplifier

2 is embodied as a source follower and thus as a power
amplifier with MOF field effect transistors (MOSFET's) in
drain circuit. By this embodiment of the amplifier 2 and
thus of the joint driver output stage for all transmitter
5 antennas $LF_{1...n}$ the rise time of the square wave or
trapezoidal output voltage at the outlet LF_{out} of the
amplifier 2 or of its output stage is restricted. By means
of this the electromagnetic radiation and thus the
electromagnetic compatibility (EMV) is kept particularly
10 low. A further restriction of the electromagnetic radiation
or EMV is advantageously achieved by a proper edge shaping
the preferably trapezoidal or square wave output voltage
(LF_{out}).

15 For this purpose the input signal PWM_{in} delivered by the
control logistics 14 of the regulation device 10 at the
input P_{in} of the power amplifier 2 is converted into
referential currents via a buffer B1 and two basic circuits
formed by the resistance R2 and the transistor T1 as well
20 as the resistance R3 and the transistor T2. They are
mirrored with current mirrors SS1, SS2 each at the highest
or lowest potential (+VH = U_B + 5V), (-VH = -5V). The
current mirrors SS1 and SS2 connected to the respective
power supplies +VH and -VH of the amplifier 2 are current-
25 controlled current sources, which transfer the current
impressed on the input side into the condenser C1.

The (mirrored) referential currents charge the condenser C1
via the cascode steps formed by the diode D1 and the
30 transistor T3 or the diode D2 and the transistor T4, the
potential at the condenser C1 changing between
approximately the potentials +VH and -VH. Here, the slew
rate of the charging voltage at the condenser C1 is

adjusted with the resistances R2, R3 and with the capacity of the condenser C1. With a network formed by the transistors T5, T6 and the diodes D3, D4 and the resistances R4, R5, R6 the voltage ramp at the condenser C1
5 can be decelerated (edge shaping) additionally in the region of the supply voltages +VH and -VH.

By the shown interconnection of the transistors T7 to T10 with the resistances R7 to R10 a current amplifier is
10 formed, which decouples the voltage at the condenser C1 and triggers an output stage driver T15, T16. For this purpose the transistors T11 and T12 and the resistance R11 form a switchable current source, whose output current is mirrored with the two current mirrors SS3 and SS4 at the highest or
15 lowest potential +VH or -VH, respectively and is decoupled via the cascode step formed by the diode D5 and the transistor T13 and the diode D6 and the transistor T14, respectively. The current mirrors with cascode (SS1, D2, T4; SS2, D1, T3; SS3, D6, T14; SS4, D5, T13) offer the
20 advantage of high output resistances and high amplifications in the respective driver stages T7 to T10 and T15, T16 of the amplifier device 2.

The decoupled symmetrical current flows through a network
25 formed by the diodes D7, D8 and the resistances R12, R13 and thus produces an offset voltage for triggering the control inputs of the output stage of the amplifier 2. The output stage is formed by MOS field effect transistors T17 and T18 in source-follower configuration, so that the
30 offset voltage triggers their gates. By the constant powering of this network D7, R12; D8, R13 the gate voltage offset remains constant over the entire range of the triggering, merely the center voltage having to be

controlled at the resistances R12 and R13 by the current
amplifier T7 to T10, R7 to R10.

If the resistances R12 and R13 are substituted by a network
5 with temperature-sensitive resistances, in particular by
NTC-resistances with negative temperature coefficients, the
offset can be affected such that the cross flow in the
outlet or output stage formed by the MOSFET's T17 and T18
remains almost constant over a large temperature range.
10 Alternatively, this property can also be achieved by
controlling the respective referential current depending on
temperature. For this purpose either the resistance R11 can
be substituted by a temperature-sensitive resistance or the
basic voltage at the transistor T11 can be modulated by an
15 external control device.

The offset voltage controls via the emitter follower formed
by the transistors T15 and 16 directly the respective gate
of the output stage transistors T17 and T18. Here, it is
20 ensured by a network formed by the resistance R14 and the
condenser C2 that the gates of the output transistors T17
and T18 can be moved dynamically in both directions.
Instead of this network R14, C2 alternatively also
complementary followers for triggering the output stage
25 transistors T17, T18 can be used. With a clamping network
formed by the diodes D9 to D12 it is ensured that in the
event of a short-circuit at the amplifier outlet LF_{out} the
maximum admissible gate-source-voltage of the output
transistors T17, T18 is not exceeded and that for this
30 reason they cannot be destroyed.

Via operational amplifiers OPV1 or OPVs connected with the
resistances R15 and R16 the currents in the output paths of

the output stage transistors T17 or T18 are measured and are monitored for diagnostic purposes. By an appropriate linkage of the detected currents value with the transmitter current I_{LF} the output stage formed by the two output

5 transistors T17 and T18 can be protected against thermal destruction in the event of a short-circuit or an overload at the outlet LF_{out} and against an excessive cross flow in the output stage T17, T18.

10 The 5V-ENABLE input serving for deactivating the power amplifier 2 shuts down the current sources of the basic circuit comprising the transistor T1 and of the network comprising the transistor T5 and the of switchable current source comprising the transistor T1. In the deactivated

15 state of the power amplifier 2 (ENABLE = low) these current sources are deactivated and thus the output stage transistors T17, T18 are high-impedance switched.

By the current measurement diagnosis signals HS_{diag} or LS_{diag}
20 generated in the in the outlet or output stage transistors T17 and T18 are supplied to a control device (not shown), which protects the power amplifier 2 in the event of a short-circuit or an overload at the outlet LF_{out} and/or against increased cross flow.

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By using a power amplifier 2 of this type with restricted rise time and particularly favorable saturation behavior the electromagnetic radiation is restricted to reliable values without additional filter measures at the outlet

30 LF_{out}. Here, by a symmetric embodiment of the circuit flanks the slew rate of the square wave or trapezoidal output voltage of the power amplifier 2 can be largely reduced while avoiding impact on the properties of the transmitter

current regulation 10. With this active impact on the circuit flanks the electromagnetic radiation of the transmitting amplifier 1 and thus of the transmitting device 1 is minimized.

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All in all by using merely one single power amplifier 2 for jointly triggering the plurality of longwave-transmitter antennas $LF_{1...n}$ the amplifier properties are particularly favorable while avoiding an ineffective increase of the

10 total expenditure. In particular, by the active impact on the circuit flanks, i.e. restriction of the rise time and of edge shaping of the square wave or trapezoidal output voltage of the power amplifier 2 the transmitting device 1 can be operated without additional filter expenditure in a

15 motor vehicle. Here, the electromagnetic radiation can be kept particularly low.

In relation to a sinusoidal triggering of a transmitting device in the longwave region, whose transmitter coil is

20 operated in parallel or series resonance, the described triggering method by means of square wave or trapezoidal output voltage is particularly advantageous with regard to the low circuit expenditure thus achieved and the low power loss in the power output stage T17, T18 of the power

25 amplifier 2.

Also a costly regulation of the transmitting power and use in a power output stage for each transmitting stage or each transmitting branch is not necessary. The reason for this

30 is that the output stage T17, T18 of the power amplifier 2 is operated in saturated manner and, therefore, in the output stage driver T15, T16 only low power loss occurs. Moreover, the transmitter current I_{LF} can be regulated by

means of pulse width modulation, what further reduces the circuit expenditure. The fact that the antennas $LF_{1....n}$ can be connected directly to the outlet LF_{out} of the power amplifier 2 results in that a plurality of transmitters can

5   be triggered from a central control device. Here, the triggering expenditure is reduced in particular also by the use of a power multiplexer 4.

List of reference numerals

	1	Transmitting device
	2	Amplifier
5	4	Multiplexer
	6	Ground branch
	8	Shunt
	10	Current regulation
10	12	Current detector/comparator
	14	Control logistics
	16	AND-gate
	18	Sequential circuit/PWM-latch
15	AZ_n	Antenna branch
	B	Buffer
	C	Condenser
	D	Diode
	E_n	Input
20	E_{ebl}	ENABLE-input
	HS_{diag}	Diagnosis signal
	LF_n	Transmitter antenna
	LS_{diag}	Diagnosis signal
	I_{LF}	Transmitter current/actual value
25	I_{Ref}	Referential current/desired value
	L_n	Transmitter coil
	LF_n	Transmitter antenna
	LF_{out}	Outlet
30	LF_{clk}	Clock signal
	M_c	Control signal
	P_{in}	Control input
	R	Resistance
	S_T	Trigger signal
35	SS	Current mirror

T	Transistor/MOSFET
U_B	Operating voltage
VH	Supply voltage/potential

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